

On-chip Spectroscopy of PbS/CdS Colloidal QDs using Superconducting Nanowire Single Photon Detectors (SNSPDs) on a Silicon Nitride Photonic Platform

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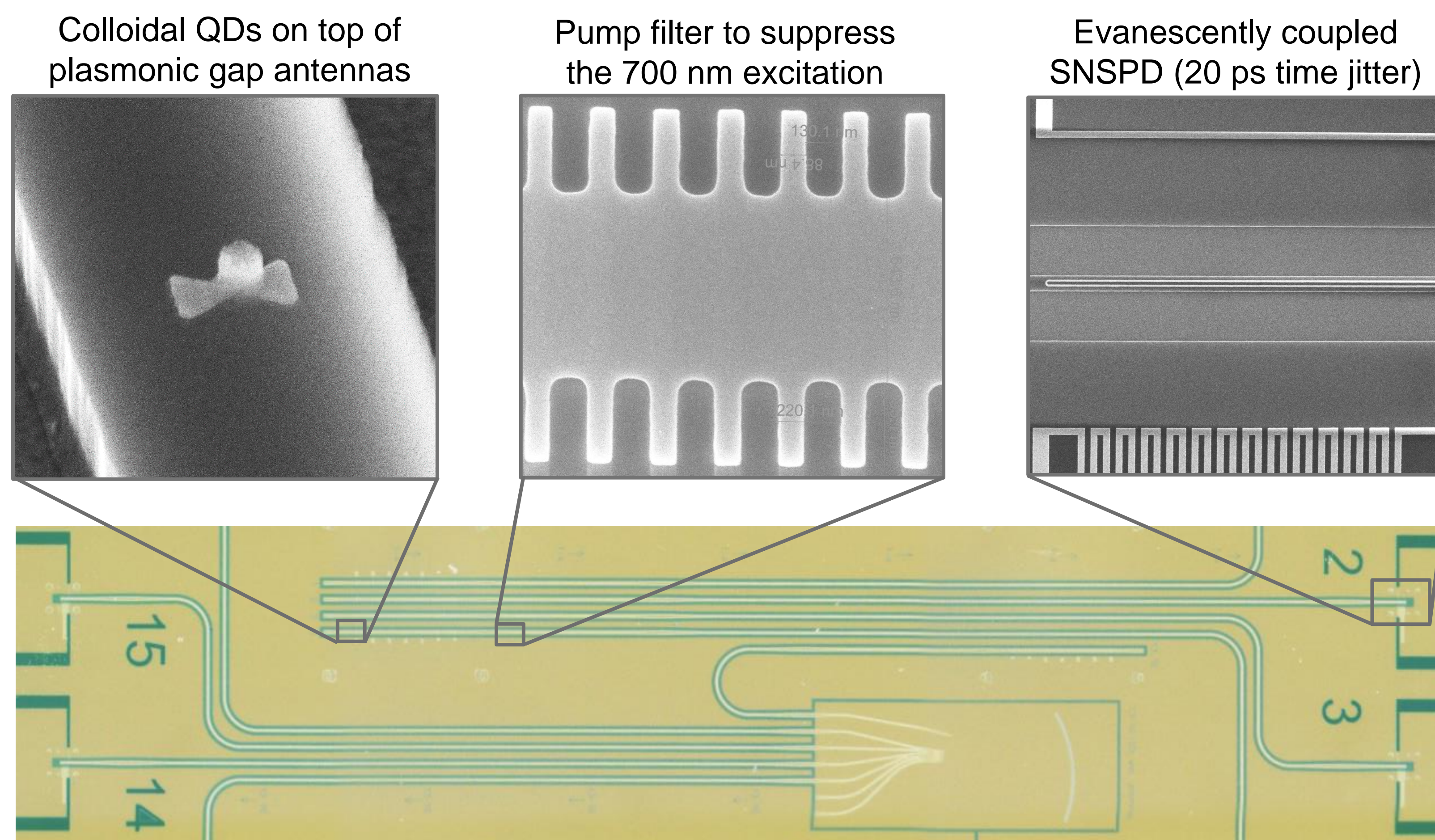
Application of on-chip quantum emitters and single-photon detectors

Single photon source for **quantum key distribution** (competing with attenuated laser + decoy state protocols):

High single-photon rate, but relaxed conditions for photon purity $g^2(0)$, average photon number per pulse $\langle n \rangle$ and indistinguishability compared to (linear) optical quantum computing

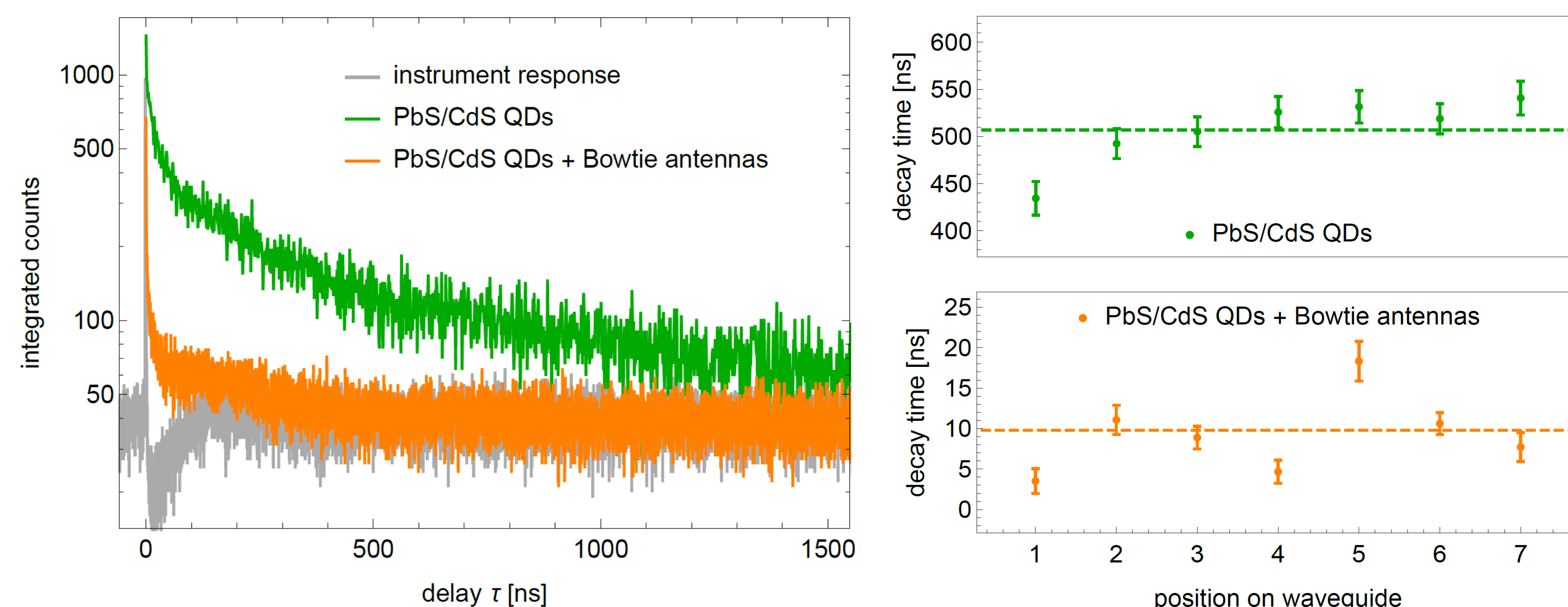
Integration platform for **post-processing** sensitive quantum **emitters** onto waveguides coupled to high-quality SNSPD detectors grown on a flat substrate

Emission enhancement of PbS/CdS QDs using plasmonic gap antennas measured with integrated superconducting nanowire detectors



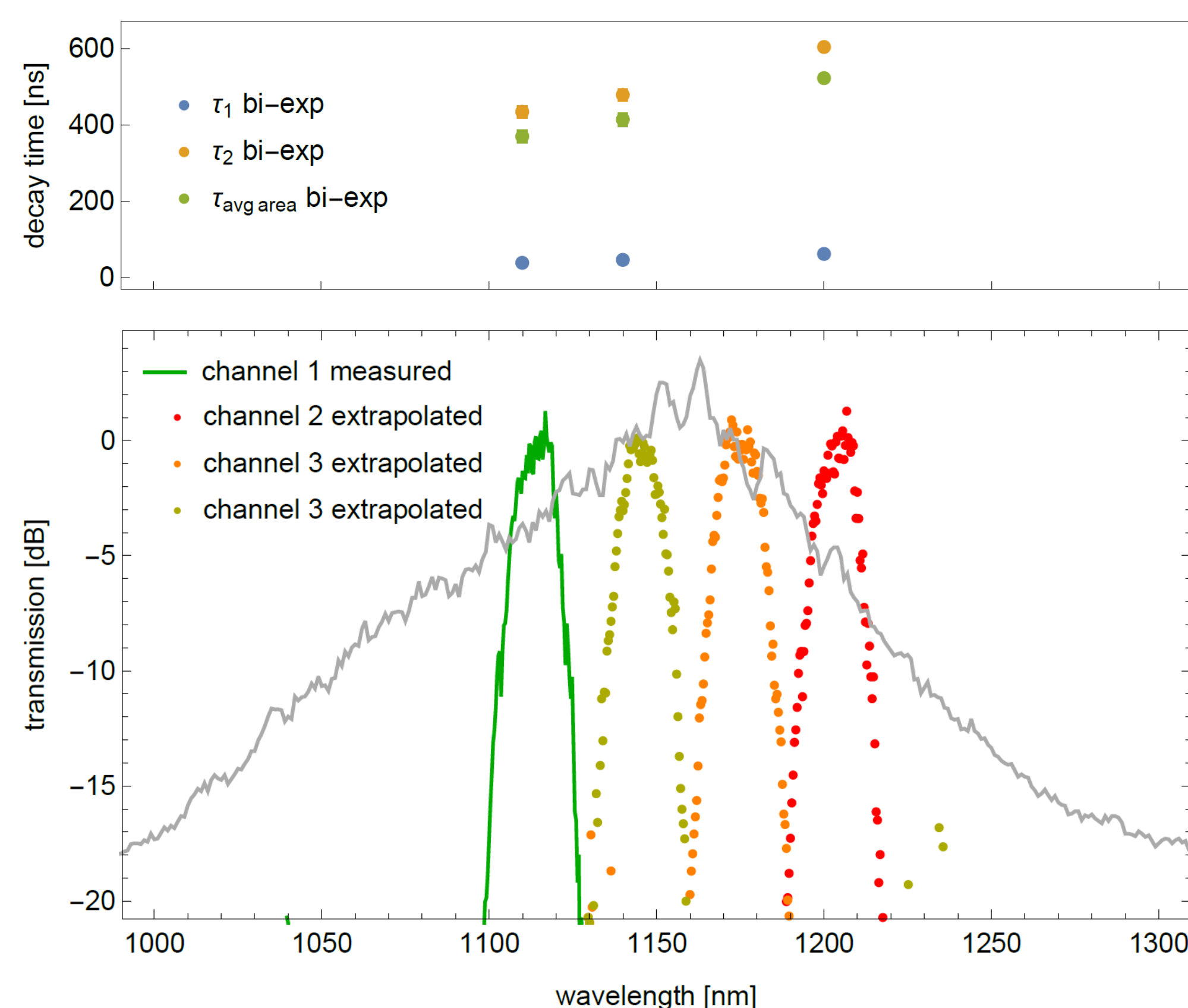
Low loss ($<1\text{dB/cm}$ @ 1300 nm) low fluorescence PECVD silicon nitride waveguide circuits on a photonic chip inside a He cryostat @ 4K.

An **average enhancement factor of 50** and a **maximum of 125** was obtained by area-averaging the decay times extracted from a bi-exponential fit of the fluorescence decay trace.

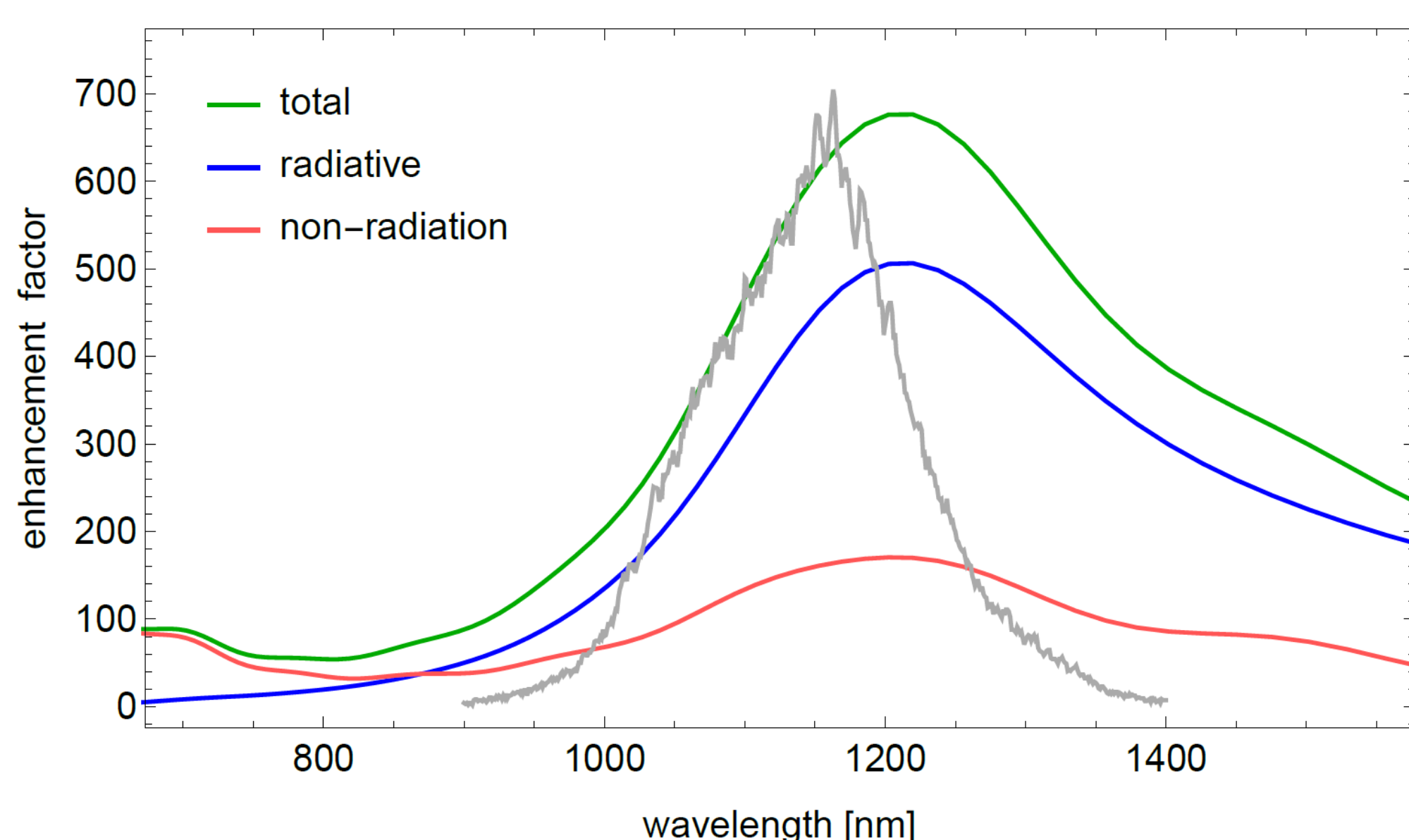


Fluorescence lifetime spectroscopy using an integrated planar concave grating

revealed a wavelength-dependence of the PbS/CdS QDs luminescence decay for an embedded film.



The PbS/CdS QD emission spectrum at 4K overlaps with the antenna resonance simulated using dimensions from SEM images. This was confirmed by separate transmission measurements not shown here.



FDTD Simulation: Up to 500-fold radiative enhancement, QE >70%

SEM pictures show a good overlay accuracy of colloidal QDs post-processed on plasmonic bowtie antennas on top of SiN waveguides, suggesting that we should achieve higher average radiative enhancement by reducing the size of the QD patches.

